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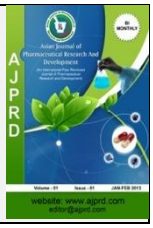

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Review Article

Stem Cell Therapy for Myocardial Infarction: A Mini-Review

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ABSTRACT

Stem cells are undifferentiated cells that can proliferate, regenerate, develop into differentiated cells, and produce a variety of tissues. Embryonic stem cells, adult or somatic stem cells, and pluripotent stem cells are the three types of stem cells. Another classification of stem cells is totipotent, multipotent, and unipotent cells. Stem cell treatment has the possibility of treating degenerative disorders, cancer, and the restoration of damaged tissues, all of which now have no or restricted medicinal alternatives. Myocardial infarction is a potentially fatal condition caused by the permanent loss of cardiomyocytes and a deterioration in the heart's blood-pumping capacity. Throughout the last two decades, stem cell-based treatments for myocardial infarction therapy have been researched with encouraging results. Traditional therapy for myocardial infarction slows disease development but has little effect on healing. Because of their ability to initiate de novo cardiogenesis, embryonic stem cells are thought to be a potential candidate for cardiac regeneration.

Keywords: Myocardial Infarction; stem cell therapy; pluripotent stem cells; adult stem cells;

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INTRODUCTION

Cardiovascular diseases (CVDs) are still the leading cause of death globally, accounting for more than 17 million fatalities per year. Myocardial infarction (MI) is a pathologic event induced by myocardial ischemia caused by abrupt full closure of a coronary artery, in which there is an indication of cardiac damage or necrosis, resulting in the death of a portion of the myocardial muscle [1,2]. MI is a prevalent trigger for heart failure (HF) caused by a partial or total obstruction of the coronary artery [3]. It contains several mechanisms that result in cellular damage or death, followed by scar formation, mechanical dysfunction, and structural integrity loss [4,5].

The epidemiology data for MI over the last decade has demonstrated that the number of MI-affected individuals is growing. MI and concomitant CVDs account for 30% of worldwide mortality and are the biggest cause of mortality in the United States [6,7]. The pathogenic event of MI occurs in the loss of cardiac tissue, which results in scar formation, which results in irreparable cellular damage [8,9]. Previous studies have indicated that cardiac tissue may regenerate, however, the substantial loss cannot be recovered in a reasonable length of time. Scar tissue is assigned over the site of the damage as a result of the healing mechanism. The scar is non-contractile, causing abnormalities in the heart rhythm and hemodynamic system. The accumulation of all instances leads to HF over time [10,11].

Current therapeutic interventions, such as medication and coronary revascularization, merely address symptoms and increase the individual's odds of life, but do not assist in recovering or rebuilding the damaged heart tissue of the person. As a result, there is a financial loss, additional follow-ups, an increased chance of mortality for the person, and mental disorders for his/her family and friends [12]. However, studies over the years have revealed that the unique technique of utilizing stem cells might be a potential option for heart tissue regeneration [13].

Stem cells are the only cells that can regenerate and differentiate. This stem cell capability promises a specific approach. The usage of stem cells will allow them to develop into cardiac tissues as well as diverse endothelium and smooth muscle cells, allowing them to rebuild the myocardium [14]. Furthermore, stem cells are well-known for their predominance in paracrine substances and activities. This powerful paracrine action leads to extended cell longevity and decreased cell mortality, increased vessel creation, aids, maintains, and regulates the inflammatory response, and enhances cardiac cell proliferation. Many therapeutic trials have employed multipotent stem cells such as Bone Marrow-Mesenchymal Stem Cells (BM-MSCs), Adipose-Derived Stem Cells (ADSCs), and Cardiac Stem Cells (CSCs) [15]. The clinical trials have yielded very good outcomes and have proven to be quite safe for MI patients. Many clinical experiments have demonstrated that the use of pluripotent stem cells (PSCs) such as Embryonic Stem Cells (ESCs) or induced-PSCs (iPSCs) and derived cells may be effective and reliable in animal studies [16]. In recent years, research has demonstrated that cardiomyogenic cells (CMCs)have powerful regenerative and paracrine effects, although their differentiation towards the original CMCsis poor [17,18].

VARIOUS STEM CELLS, THEIR ORIGIN, AND MI TREATMENT

Stem cells are classified into three types: ESCs, adult or somatic stem cells (SSCs), and PSCs. Human ESCs are substantially more genetically stable, easily differentiable, and have a higher proliferative ability than adult stem cells (ASCs). Other stem cell types, tumorigenicity, and the immunogenic potential of host body acceptance or rejection are all key considerations. Furthermore, given the ethical concerns, the generation of the ESCs appears to be problematic [19]. As an example, Previous research has revealed that embryonic stem cells result in the development of CMCs. When implanted, these CMCs might be utilized to cause arrhythmia [20].

Again, ASCs and SSCs are essentially categorized into two classes. The first are hematopoietic cells, while the second are MSCs. MSCs can develop into bone marrow cells, immature skeletal cells, CSCs, endothelial progenitor cells, and human umbilical cord while hematopoietic cells proliferate and differentiate into blood cells [21]. As a result, there are several effective resources accessible for getting MSCs. MSCs can be derived from bone marrow, blood, adipose tissue, umbilical cord, adipose tissue, and placenta. These MSCs can be discovered in biological fluids such as breast milk, urine, and amniotic fluids [22].

Ardeshirylajimi et al.proposed that certain places on the MI might reveal alternate or different features. The study proposed that anatomical sources of fat tissue might influence cell differentiation and numerous features. The adipose tissue produced from the hump exhibited more alkaline phosphatase activity, while the adipose tissue obtained from the abdominal area had lower calcium content [23]. According to one research, using stem cells leads tofewer tumorigenic responses and has an outstanding response to gene transfer. Furthermore, ASCs or SSCs have a shorter time to adjust to the regeneration capacity and are extremely difficult to remove from the body [24].In comparison to ASCs, SSCs, and ESCs, iPSCs offer the most recent research potential. Induced stem cells are quite beneficial in terms of gene expression and epigenetic alteration. These modifications aid in the transformation of normal cells into stem cells. Induced viral vectors were the first-choice instruments for changing normal or somatic cells during the stem cell modification process. Thus, ectopic transcription of certain genes might result in cancerous stage or tumorigenicity [25]. Several chemical compounds have been employed in recent years to improve the efficacy of reprogramming and the efficiency of iPSCs. These are concentrating on lowering the requirement for tumorigenic or gene modification [26].A recent study found that regulated impulses can stimulate CMCs to regenerate the same CVD-specific iPSCs. The electrical shocks were regulated with a certain amplitude for a set period, resulting in enhanced release and production of troponin T positive cells, a cardiac protein [27].Cell surface markers such as a cluster of differentiation 117 (CD117) and Proto-oncogene (c-kit) can be employed to successfully isolate CSCs [28]. Furthermore, mast cells can express c-Kit in human heart cells. Mast cells and their derivatives, for example, might be extensively utilized in labeling and recognizing the various types of cells in the MI Site [29].According to one study, c-Kit expression isn't the sole element that contributes to the isolation of CSCs. According to the findings, a tiny proportion of CD45 negative stem cells have modest self-renewal capacity, but c-kit positive cells have substantial self-renewal capacity, indicating their multipotent regenerative potential [30].

The most significant component during a MI episode is time constraints and their significance. The tailored preparation of autologous stem cells is time-consuming and labor-intensive. As a result, the appropriate application of Stem Cell treatment in clinical and emergency settings is a major issue as well as a limiting factor. Treating a recent MI, on the other hand, is simpler than treating an older MI or HF [31]. The period necessary for the allogenic stem cell to function at its peak effectiveness was detected within 7 days following the MI event. This impact was likewise connected to and was primarily associated with increased angiogenesis [32,33].Furthermore, stem cell cultivation must be performed before placement. That is, the majority of CSCs will be inserted after the MI, which has both an ischemia and an inflammatory environment. Thus, cultivated CSCs in this type of circumstance may boost the chances of success while also increasing the likelihood of survival. Thus, supplementing the cultured medium and growing environment with the Simple Fibroblast Growth Factor, Endothelial Growth Factor, and Platelet-origin Growth Factor increases the longevity, survivability, and increased functionality of stem cells [34,35].Proangiogenic growth factors, anti-apoptotic factors, and stem cells all contribute to enhanced survival [36]. Furthermore, prostaglandin E2 prevents stem cell rejection and improves heart function [37].

CONCLUSION

Stem cell treatment appears to be a potential general-purpose treatment, but because each person's stem cells are unique, therapies must also focus on helping tailored care. These CSC medicines and innovative strategies have broad

therapeutic promise and must be identified sooner rather than later. In stem cell treatment, variables such as aging and other personal circumstances might have an impact on the host's state, leading to major consequences. Similarly, as individuals age, their coronary artery potential acceptance of CSCs decreases. Looking into the donor and recipient's past can also help in stem cell harvesting and acceptance. Thus, advancements in stem cell therapy, as well as ongoing research into the optimum delivery route and technique, are required. Before we employ stem cells to treat MI, many key practical concerns must be addressed. The main problem is the immature phenotype because the development of stem cells and their maturity state vary greatly from cell to cell. SCT holds a lot of potential for the treatment of MI. Many ethical and political problems have arisen in light of the advantages. The development of pluripotent stem cells from oocytes and embryos raises questions about human identity. Any kind of cell derivation for stem cell treatment must be signed with permission. As a result of preventing ethical dilemmas, each new medical experiment raises ethical considerations for individuals and scientists. In the coming years, the most cost-effective, timely, and experienced delivery technique will emerge.

CONFLICT OF INTEREST

The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

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